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Climate and Health in Michigan.*

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EVERY one speaks of the weather and of the health in close connection, and yet few people realize how closely health is dependent upon weather and upon climate. To illustrate this, a diagram is here given, in which one curve represents the rise and fall of temperature in Michigan; the average for several stations for a series of six years (1877-82) being shown here by months, together with a curve of the rise and fall of sickness from diarrhoea (an average for the same six years), from which it may be seen that in that part of the year in which the temperature is high, there is a close correspondence between the two curves. In the same diagram is a line representing sickness in the same year from pneumonia (inflammation of the lungs), and it may be seen that if the temperature curve were reversed, that is, made to descend to represent the rise in temperature, the two curves would be very similar. The sickness-curve should rise and fall later than its cause by about the average duration of the disease, plus the length of the period of incubation (if such there be); because the reports of sickness include all cases under observation, old cases and new ones. The time-unit of the diagram is one month, which is probably more than the average duration of pneumonia; but pneumonia prevails a little after the cold weather has begun, and continues after the weather has grown warm; hence, in the accompanying diagram, the rise or fall in the line representing sickness from pneumonia appears to be a month later than the corresponding fall or rise in the temperature; in a compilation by weeks, the interval between the two lines would, perhaps, be less. Similar remarks may be made of the relation of the sickness from diarrhoea to temperature, substituting the words, "hot weather" for "cold weather," because, while studying sickness from diarrhoea, the curve for temperature does not need to be reversed, as it does when studying pneumonia.

For several years the Michigan State Board of Health has had a number of meteorological observers in different parts of the state, taking observations three times a day; and some of them are supplied with registering instruments which make continuous records. The Board has also had from many different parts of the state weekly reports of the sickness which has occurred, so that there is no state in the Union, and probably no such area in the world, concerning which, the relations which the health of the inhabitants bears to the climate can be written about and studied with reference to the exact facts, so thoroughly as can be done for the State of Michigan.

Without a greater number of reports than are now received, it is not possible to make accurate comparative estimates of the sickness in different small localities, but the reports now received are sufficient in number to make very satisfactory data for the state as a whole, because of the great probability that 100 observers in active practice in as many different parts of the state will, on the average, see and report an average of the diseases which prevail throughout the state. The system has been in operation long enough and has been tried in ways sufficiently numerous to prove that the evidence is trustworthy. It can now be truthfully claimed that the time of year of greatest danger from most of the important diseases has been learned for this state; and not only this, but the meteorological and other conditions which are coincident with those times of greatest danger have also been learned, relative to several of the diseases which cause most sickness in Michigan. This supplies for each of those diseases a clue to the methods which must be adopted for its prevention. Thus far the results have been brought together and grouped for only one of those diseases—typhoid fever—and for that disease not perfectly; yet the grouping of the evidence as is done in the paper entitled "The Relation of the Depth of Water to the Causation of Typhoid Fever" has re-

* Revised by the author, September, 1885, from his paper in *Descriptive America*, for 1884.

sulted in a much clearer view of the need for preserving the purity of the drinking-water than it had been possible to get previous to such grouping of the evidence. The diagram accompanying this paper may indicate that we are about ready to group the evidence relative to pneumonia; and although its causation is very different from that of typhoid fever, it is believed that many lives can be saved, and many cases of sickness prevented, after the facts bearing upon its causation shall have been grasped by the people.

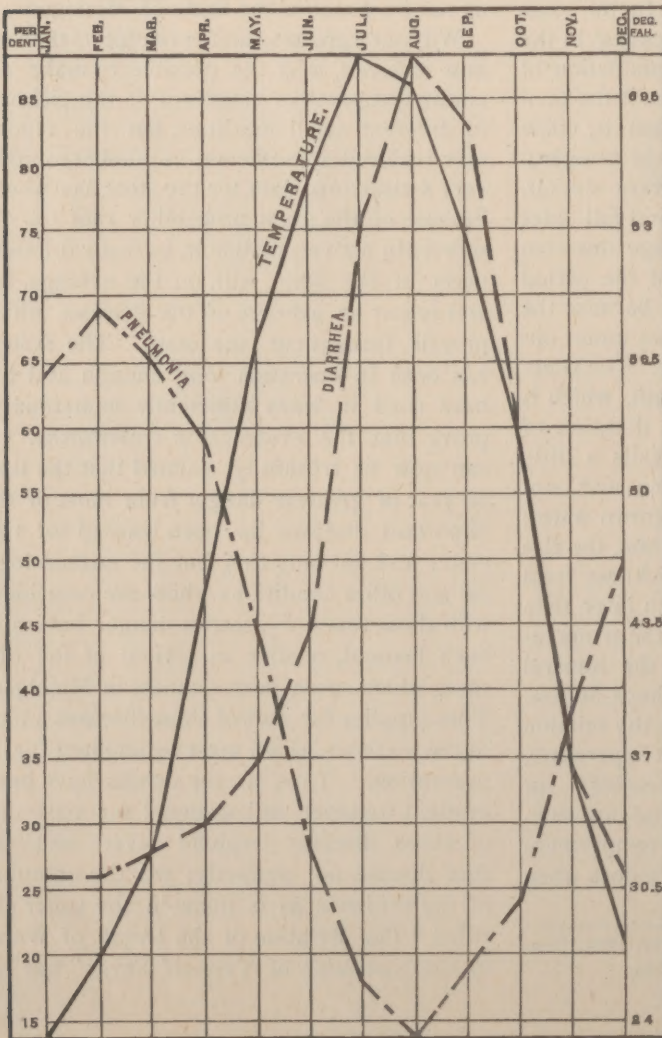
Those elements of climate which are generally supposed to have the closest relations to health are :

1. Temperature in its fluctuations.
2. Humidity.
3. Rainfall.
4. Cloudiness (sunshine).
5. Winds.

TABLE 1.—Latitude and Longitude, Elevation above Sea Level, and the Average Temperature, in 1882, at 22 Meteorological Stations in Michigan,—the names of the stations being arranged in order by latitude, highest first.

LOCALITIES IN ORDER OF LATITUDE.—THOSE FARTEST NORTH, FIRST.	Latitude North.	Longitude West from Greenwich.	Altitude (Approximate) above Sea Level,—Feet.	Average Temperature, 1882. Degrees Fahr.
Marquette.....	46°33'	87°36'	638.07	42.28
Escanaba.....	45°46'	87°14'	594.693	42.76
Alpena.....	45°5'	83°28'	587.9	42.68
Traverse City.....	44°45'	85°40'	598.	45.13
Harrisville.....	44°39'	83°18'	44.62
Reed City.....	43°44'	85°28'	1,016.	45.63
Otisville.....	43°13'	83°31'	820.	47.21
Grand Haven.....	43°5'	86°18'	595.3	48.18
Port Huron.....	42°58'	82°29'	600.	45.78
Thornville.....	42°55'	83°12'	975.	49.02
Lansing.....	42°44'	84°33'	900.	49.23
Hastings.....	42°40'	85°17'	750.	47.94
Washington.....	42°40'	83°	746.33	46.85
Winfield.....	42°30'	84°34'	47.82
Detroit.....	42°20'	83°2'	602.6	51.20
Battle Creek.....	42°20'	85°11'	800.	50.20
Kalamazoo.....	42°18'	85°35'	975.	48.69
Ann Arbor.....	42°17'	83°44'	930.	47.31
Marshall.....	42°17'	84°58'	885.	49.58
Mendon.....	42°2'	85°29'	871.	48.91
Tecumseh.....	42°1'	83°57'	835.	48.06
Hillsdale.....	41°55'	84°34'	1,139.	47.70

DIAGRAM.—Average Temperature, and Per Cent. of Weekly Reports stating presence of Diarrhea and Pneumonia, in Michigan, 6 years, 1877–82.



6. Ozone.

7. Malaria, or marsh miasm.

The last-named, though usually least capable of scientific analysis, has been considered of more consequence than any of the others.

These elements of climate may be touched upon in the above-indicated order.

1. The extent of territory north and south is so great that there is a considerable difference between the temperature of the most northern and that of the most southern part of the state. What that difference is, and several other facts, can be well shown by such a table as Table No. 1.

The average temperature for several stations in Michigan, for the six years (1877–82), is stated by months, in Table No. 2, which is given below.

The author of the article on "Climate" in latest edition of the Encyclopædia Britannica, after speaking of a region which he claims presents more sudden transitions of climate than any other portion of the globe, says (page 6, vol. VI.): "A direct contrast to this is offered by the United States to the east of the Mississippi, a region characterized by a remarkable uniformity in the distribution of its rainfall at all seasons, which, taken in connection

with its temperature, affords climatic conditions admirably adapted for a vigorous growth of trees, and for the great staple products of agriculture." He might have added that for similar reasons, the climate is also admirably adapted for the maintainance of vigorous health. So far as relates to the equability of the temperature, Michigan is the most favorably situated of these favored states, because of the great lakes which nearly surround the state except on its southern border, and which tend to still further equalize the temperature, by cooling the air in summer and warming it in winter, these being well known effects of large bodies of water. The modifying effect on the summer temperature is perhaps most noticeable in June, which is a very delightful month in Michigan.

The average daily range of temperature in Michigan, as shown by self-registering thermometers, is shown in one line of Table No. 2. If computed from observations made only three times a day, instead of continuously, it would appear much less.

2. The absolute humidity of the atmosphere is now known to have close relations to healthfulness, as respects quite a number of diseases; a warm, moist atmosphere being favorable to health so far as regards the lungs and air passages, and unfavorable to children and others liable to suffer from diarrhœa and diseases of the bowels and digestive organs. The curve in the diagram representing the absolute humidity in Michigan is very nearly the same as the curve representing the sickness reported from diarrhœa, from cholera-infantum, or from cholera-morbus; and as the quantity of moisture in the air is greatly dependent upon its temperature, increasing as the temperature rises, and decreasing as it falls, any cooling of the atmosphere in summer by the great lakes tends to lessen the actual humidity of the atmosphere at the very time of the year when most beneficial, that is to say, when humidity is most harmful; on the other hand, any warming of the winter air by passing over the great lakes, tends to increase its humidity at the very time of the year when most needed, that is to say, when dryness of the air seems to be most harmful; * because

the investigations which have been carried on in this state during the past ten years have proved that the sickness from bronchitis, and from inflammation of the lungs, increases immediately after the occurrence of cold, dry air, and decreases immediately after the occurrence of warm, moist air; the curves for

TABLE 2.—Meteorological conditions in Michigan,—the temperature being stated in degrees Fahr.; the absolute humidity, in grains of vapor in each cubic foot of air; the relative humidity, in hundredths—complete saturation being 100; the rainfall in inches; the cloudiness in percent. of sky covered by clouds; the velocity of the wind in miles per hour; and the ozone, in degrees of a scale in which the maximum is 10.

Meteorological Condition.	Annual Average.	Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Average Temperature*.	47.61	23.42	27.30	32.49	45.14	57.84	65.42	71.73	69.89	62.41	52.07	35.88	27.72
Daily Range of Temperature†.	17.71	10.17	17.33	16.17	19.32	21.34	19.80	19.77	19.15	18.46	17.74	14.55	12.58
Absolute Humidity‡.	3.57	1.52	1.67	1.97	2.81	4.07	5.30	6.27	6.10	5.12	3.90	2.32	1.81
Relative Humidity§.	75	81	79	76	68	66	71	74	74	75	76	79	82
Inches of Rain and Melted Snow*.	38.67	1.89	2.37	2.97	2.92	3.26	4.29	3.72	3.79	3.59	3.82	3.49	2.65
Percent. of Cloudiness*.	55	67	59	63	50	44	48	40	44	45	56	69	78
Velocity of wind, per Hour and Miles§.	9.6	11.5	11.7	11.8	11.1	10.1	8.7	8.5	6.9	7.5	8.6	8.6	10.1
Ozone (during night)*.	3.14	3.86	4.00	4.29	3.60	3.18	2.91	2.37	2.20	2.30	2.82	3.41	3.60

* Average for six years, 1877—82, at several stations in Michigan.
† Average for five years, 1878—82, at several stations in Michigan.
‡ Average for four years, 1879—82, at several stations in Michigan.
§ Average during the year 1882 by self-registering anemometers, at 8 stations in Michigan.

* The writer knows very well that in England it is claimed that it is the cold, moist air which is most coincident with diseases of the lungs and air-passages; but it must be understood that when those who have studied the subject in England speak of humidity, they do not mean the actual humidity, but on the contrary, they refer to relative humidity or per cent. of saturation, the curve for which is very different from the curve of absolute humidity.

these diseases being somewhat like and following the reversed curve for absolute humidity.

2. Although the relative humidity has not been proved to have very close relations to health, the facts respecting it may as well be stated, especially as meteorologists have quite

generally supposed that it must have great influence. It will be seen from the fourth line in Table No. 2 that in Michigan the air is not more than three-fourths saturated in any month in summer, when, as we now know, actual humidity of the air is unfavorable; and that the air is more than three-fourths saturated in every month in winter, when, as we now know, cold air is unfavorable because of influence in causing diseases of the air-passages. The line referred to is an average line for a period of years, and also an average for several stations; it therefore represents the state as a whole. If we are to examine the averages by months for each year, or for each station, exceptions would be found to the statement just made as to the per cent. of saturation of the air in summer and winter, but those statements are made with reference to the state considered as a whole.

3. A statement of the very favorable rainfall in the United States east of the Mississippi was given when speaking of temperature, but what the actual average rain-fall in Michigan has been may be seen by the line in table 2, where it is stated.

4. The average cloudiness is shown by a line in table 2.

5. The average velocity of the wind is shown in table 2, and no special remarks are needed, except that tornadoes are not common in Michigan.

6. The ozone, by night observations, is shown in the table. It may be remarked in passing, that the curve of the night ozone by months, when reversed, is very nearly the curve for the average sickness reported from remittent fever.

FROM WHAT DISEASE IS THERE MOST SICKNESS?

If it be asked: From what is there most sickness in Michigan? the reply is, that the reports show it to be intermittent fever. If we now turn to the mortality statistics, we find that the deaths from intermittent fever are so few as to be insignificant, compared with most other causes of death. In Michigan, as in most healthful states, the greatest number of deaths are from consumption; but the deaths from that disease are not of so large a proportion of its inhabitants as in most other states—not so large, for instance (according to the United States Census of 1870), as they were in Pennsylvania or in Louisiana.

7. *Malaria*.—A few years since Prof. Kedzie, ex-president of the Michigan State

Board of Health, and ex-president of the American Public Health Association, collected from the leading physicians of the State their opinions, and the facts upon which they were based, respecting the occurrence of malarial diseases, and the decrease in such diseases within their knowledge. The evidence was conclusive that there had been a very great reduction, and that it was probably due to the clearing of the land, and consequent drying and warming of the soil, which has been supplemented in many parts of the State by extensive drainage and under-drainage, the reclaiming of marshes, and the clearing out of swamps. Improvements in this direction are still rapidly progressing. The Michigan of to-day is no longer the Michigan of the early days of its settlement. The motto of the State—If you seek a beautiful peninsula, look about you—is now generally acknowledged to be quite applicable. The upper peninsula has its picturesque scenery and its great mineral wealth; the lower peninsula is a delightful agricultural region, thickly dotted by beautiful lakes, and traversed by pleasant streams of running water. Detroit, the beautiful City of the Straits, by the side of one of the noblest rivers in this country, is a city of which any State may well be proud. There are very many other places in the State which have a high reputation both for health and attractive scenery.

WHAT CLIMATIC CONDITION IS MOST TO BE FEARED?

The author of "Atmosphere" in the Encyclopædia Britannica, referring probably to the total deaths from all causes, says (page 30, vol. III):

"The curve of mortality for London, England, if mere infants be excepted, has thus an inverse relation to the temperature, rising as the temperature falls, and falling as the temperature rises. On the other hand, in Victoria, Australia, where the summers are hotter and the winters milder, the curves of mortality and temperature are directly related to each other—mortality and temperature rising and falling together; the reason being that in Victoria deaths from bowel complaints are much greater, and those from diseases of the respiratory organs are much less, than in London."

The time of year of greatest danger to health and to life in Michigan may be seen by the following tabular arrangement of months, and the remarks appended:

By the table below, it will be seen that the months in which there is most sickness in Michigan are September, August, October, etc.

And the diseases from which there is most sickness in Michigan in August, September, and October are: Diarrhœa and other diseases now known to have close relations to a high temperature, and the autumnal fevers—intermittent, remittent, typho-malarial, and typhoid—which seem to be in some way

months of March, April, May, etc., as shown in the foregoing tabular arrangement of months; the data for that part of it relating to Ontario being supplied by the Ontario report of the provincial Board of Health for 1883. So that one seeking a colder climate than the average in Michigan must stop short of one as cold as the average in Ontario, because there he would already have found one where the most sickness occurs in, or directly following, the cold season of the year.

Months arranged in order of the most sickness and most deaths—those named first in which there was most sickness or most deaths.

Order.	STATE OF MICHIGAN.		PROVINCE OF ONTARIO.	
	Sickness. (1877—82.)	Deaths.* (1871—82.)	Sickness. (Oct. 1882 to Sept. 1883.)	Deaths. Five years.
1	September	August	March	March
2	August	September	April	April
3	October	April	May	August
4	February	March	February	February
5	January	October	September	September
6	March	May	August	May
7	November	July	January	January
8	December	December	July	July
9	April	February	October	October
10	July	November	June	December
11	May	June	December	November
12	June	January	November	June

* Corrected for greater proportion of omissions in enumeration in early part of the year.

so related to high temperature that they generally follow it. It thus appears that the direction in which to look for a *perfect* climate is toward one slightly colder than the average of that of Michigan, at least in the summer months.

The only other sickness-statistics now being collected in this country are those of the Province of Ontario; and these have not been collected for a time sufficiently long to enable one to judge well of the relative healthfulness there during the several months;—but, so far as one year's statistics are any guide, it appears that there is most sickness there in the

In the search for a perfect climate, it must be remembered, also, that equability is of some consequence, and that there are few states so favorably situated in that respect as is Michigan. There is nothing published which shows the comparative death-rates recently in the several states,* and registration of vital statistics in Canada is so recent that no complete returns of deaths are yet received. Perhaps the best that can be done is to see how the death-rate in Michigan compared with that of other states at the time of the U. S. Census of 1870. Arranged in order, those in which the death-rate was least being placed first, the states and territories and the number of deaths to each 1,000 inhabitants are as follows :

Idaho, 3.3; Oregon, 6.9; Dakota, 7.1; Minnesota, 8.0; Wyoming Ter., 8.1; Nebraska, 8.1; Iowa, 8.1; Montana, 9.0; West Virginia, 9.1; Washington Ter., 9.3; Colorado, 9.4; MICHIGAN, 9.4; Wisconsin, 9.4; North Carolina, 9.8; Utah, 10.3; Indiana, 10.5; South Carolina, 10.5; Vermont, 10.7; Alabama, 10.8; Kentucky, 10.9; Mississippi, 11.1; Ohio, 11.1; Tennessee, 11.3; Georgia, 11.5; New Jersey,

11.7; Florida, 12.1; Maine, 12.3; Maryland; 12.4; Virginia, 12.4; Delaware, 12.5; Arkansas, 12.6; Connecticut, 12.6; Rhode Island, 12.6; New Mexico, 12.8; Illinois, 13.3; New Hampshire, 13.5; Texas, 13.7; Nevada, 14.5; Pennsylvania, 14.9; District Columbia, 15.3; New York, 15.8; California, 16.1; Missouri, 16.3; Massachusetts, 17.7; Louisiana, 20.0; Arizona, 26.1. The average for the United States was 12.8.

*At the time of revising this paper, September, 1885, the mortality volume of the U. S. Census for 1880 is not accessible to those of us who make the greatest use of such statistics.

These statistics only approximate to the truth, not all deaths being reported in any state, and though usually comparable, one state with another, this is not true with Massachusetts, in which the system of collecting the records of deaths makes the proportion of the deaths which were returned in the census larger than in many other states. Some allowance on this account should be made for the states of Vermont and Rhode Island. One more important fact should be remembered, namely, that such new states and territories as Idaho, Dakota, and Wyoming, contain very few inhabitants at those young or old ages at which the death-rate is greatest; nearly all being in middle life, at which

drainage and other improvements of the soil which occur with the cultivation, and which do so much to favorably modify the local climate shall have continued for a time as they are now progressing there, the climate in the northern portion of the lower peninsula of Michigan will be found to be about as near perfect as any in this country.

After all, there is one important fact which has been made much clearer by the systematic studies of the climatic causes of sickness, which have been carried on by the Michigan State Board of Health; and that is that some of those diseases which cause the most sickness, and which are most closely related to climatic conditions can be almost wholly con-

Total number of deaths returned as having occurred in Michigan in each of the 10 years 1873—1882; the number of deaths each year from Consumption, Diarrhœa, Intermittent fever, and Pneumonia; the per cent. of deaths from each of these diseases to the deaths from all causes; the average number of deaths for 10 years, and the average per cent. of deaths from each specified cause to the deaths from all causes, for the same period.

Deaths from :		Average Annually 1873 to 1882 inclusive.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
All causes	No.	13,299	14,253	12,500	11,590	12,576	12,919	12,766	14,407	16,102	19,238	16,425
Consumption	No.	1,567	1,447	1,392	1,479	1,590	1,664	1,641	1,680	1,829	1,954	1,804
	Per ct.	11.96	10.15	11.14	12.34	12.64	12.58	12.85	11.66	11.36	10.16	10.98
Diarrhœa	No.	317	383	380	283	304	290	173	226	310	501	259
	Per ct.	2.43	2.69	3.04	2.36	2.42	2.24	1.35	1.57	1.93	2.60	1.57
Intermittent fever	No.	48	73	62	39	36	53	47	46	32	45	34
	Per ct.	.37	.51	.50	.33	.29	.41	.37	.32	.20	.23	.21
Pneumonia	No.	624	706	800	743	627	465	462	701	812	805	735
	Per ct.	4.69	4.95	6.40	6.20	4.99	3.60	3.62	4.87	5.04	4.18	4.47

ages few die. Yet it will be seen that Michigan, though a state which has been settled long enough to have a fair proportion of both old and young among its inhabitants, is found very closely approaching the very newest of the states and territories in the smallness of its death-rate, which according to the census was only 9.4 in 1,000 inhabitants during the year.*

Probably it will be found that, after the

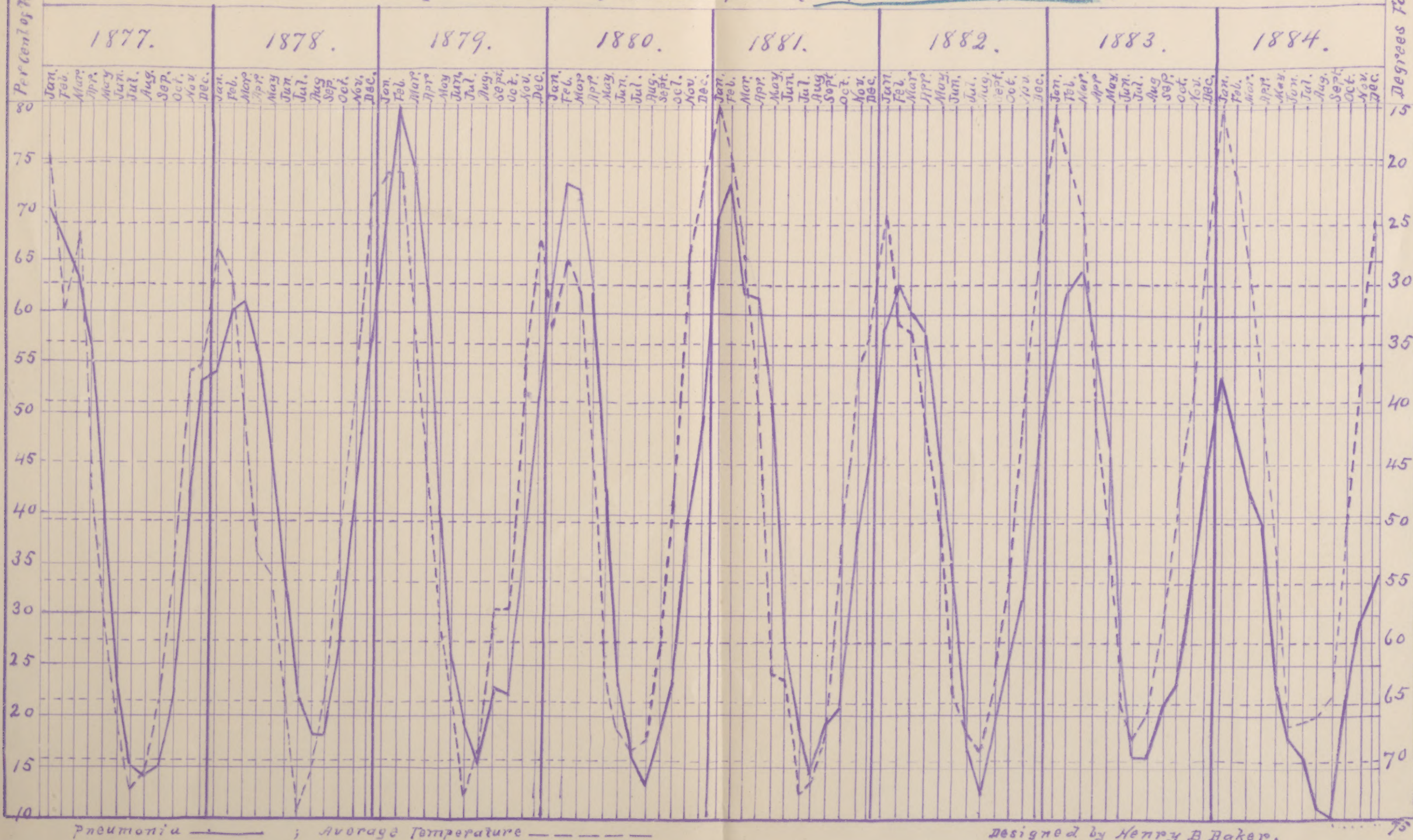
*More perfect methods than were adopted by the census make it probable that the actual death-rate was about 17.0 per thousand per annum; but these figures should not be used for comparison with the other states, because it is fair to assume that similar methods of perfecting their vital statistics would have increased their apparent death-rate in a similar proportion.),

trolled by intelligent committees. There is now, for instance, no longer any necessity for permitting a "Green Christmas" to make a "fat churchyard," because it has been pointed out* that the typhoid fever which follows on an "open winter" is probably due to the decomposing organic filth which should be, but has not been, kept out of wells which supply drinking water.

It would seem, then, that the direction in which we should seek a more healthful climate is through more exact knowledge of what elements of climate are injurious to health, and how they are injurious, so that we may place ourselves in harmonious relations to Nature's laws.

*Page 100, Report of Michigan State Board of Health, 1884.

Diagram Exhibiting By Months In Each Of The Eight Years, 1877-84, The Relation Between Sickness In Michigan From Pneumonia And The Average Temperature Of The Atmosphere (Temperature Curve, Reversed.)



Pneumonia ————— ; Average Temperature ————

Designed by Henry B. Baker.

